1 A student investigates how air vibrates in a plastic pipe.

She blocks one end of the pipe and blows across the other end.

The pipe emits a sound with a steady pitch.

The student uses a microphone to monitor the sound.

(a) Explain the meaning of the **pitch** of a sound.

(2)

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(b) The student measures the length of the pipe and the frequency of the microphone signal for two different lengths of pipe.

(i) Name two instruments that she will need for these measurements.

(2)

1 .....

2 .....

(ii) Name the dependent and independent variables in her investigation.

(2)

dependent variable .....

independent variable .....

(c) The student collects this data.

Length of pipe in m	Frequency of signal in Hz
2	42
1½	57

Suggest three ways to improve this investigation.

(3)

1 .....

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2 .....

.....

3 .....

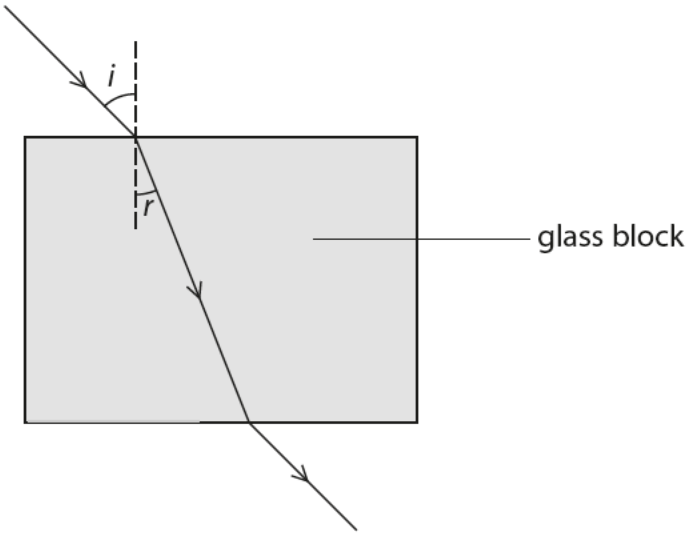
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(Total for Question 1 = 9 marks)

2 A student investigates refraction using a glass block.

She wants to find the refractive index of the glass.

She sends rays of light into the block at different angles and measures the angle of incidence and the angle of refraction.



The table shows her results.

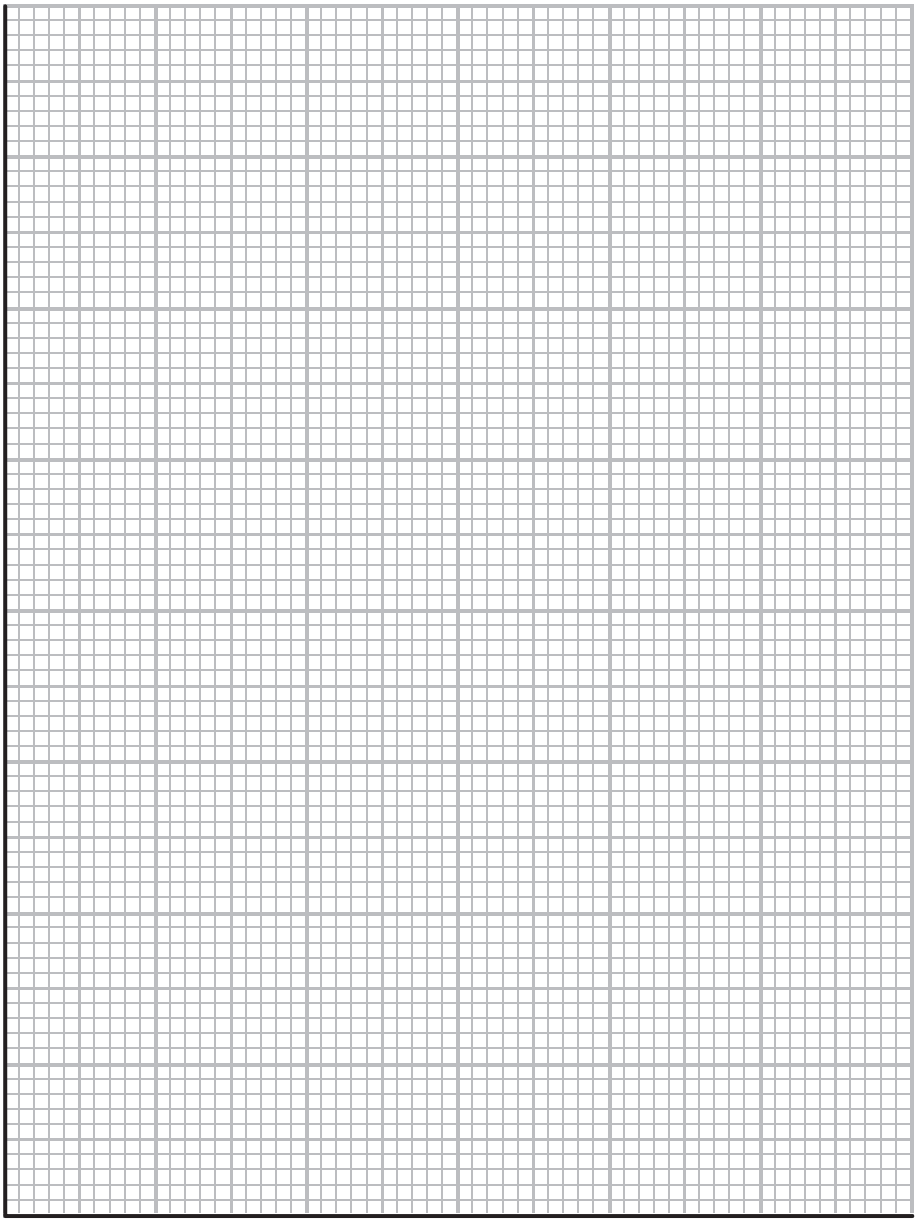
Angle of incidence, *i*	Angle of refraction, *r*	sin *i*	sin *r*
0°	0°	0.00	0.00
15°	10°	0.26	0.17
25°	16°	0.42	
35°	22°	0.57	
45°	28°	0.71	0.47

(a) (i) Complete the table by calculating the missing values of sin *r*.

(1)

(ii) Draw a graph of sin *i* (*y*-axis) against sin *r* (*x*-axis).

(5)



(iii) Use your graph to find the refractive index of the glass.

(2)

refractive index = ...

(b) Suggest two reasons why using a graph to find the refractive index is a better method than simply calculating it using a pair of angles from the table.

(2)

1 .....

.....

2 .....

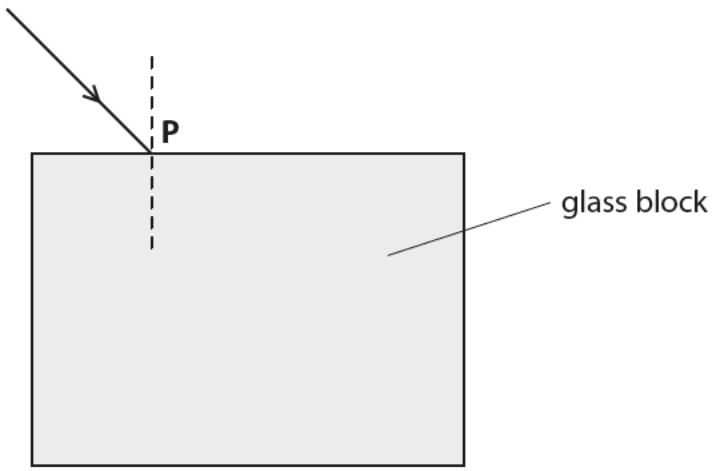
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(Total for Question 2 = 10 marks)

3 A student uses a rectangular glass block to determine the refractive index of glass.

The diagram shows a ray of red light in air as it enters the glass block at **P**.

The normal at **P** is shown as a dotted line.



(a) Complete the diagram by

- drawing the ray that continues inside the block
- labelling the angle of incidence (*i*) and the angle of refraction (*r*)
- drawing the ray that leaves the block.

(4)

(b) The student measures values for the angle of incidence (*i*) and the angle of refraction (*r*).

i	60°
r	34°
sin *i*	
sin *r*	

(i) Complete the table by inserting values for sin *i* and sin *r*.

(1)

(ii) State the equation that links refractive index, angle of incidence (*i*) and angle of refraction (*r*).

(1)

(iii) Calculate the refractive index of the glass.

(2)

Refractive index = ...

(c) How should the student continue the investigation to obtain a more accurate value for the refractive index of glass?

(3)

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(Total for Question 3 = 11 marks)

4 (a) A student wants to find the refractive index of a glass block.

(i) Draw a diagram to show how the student should set up the apparatus needed to find the refractive index of a glass block.

Label your diagram.

(2)

(ii) What measurements should the student take to find the refractive index of the glass block?

(2)

.....

.....

(iii) Describe how the student should use these measurements to find the refractive index of the glass block.

(2)

.....

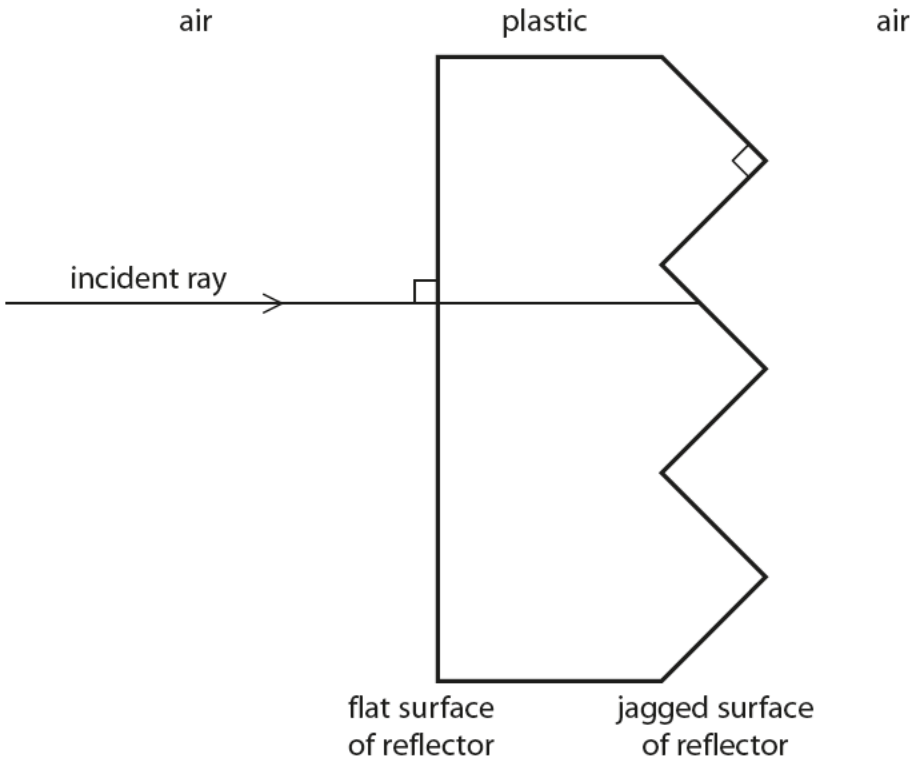
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(b) The diagram shows a section through a bicycle reflector.

A ray of light is incident on the flat surface of the reflector.



(i) The critical angle for the plastic of the reflector is less than 45°.

Continue the incident ray on the diagram to show the path of the ray until it emerges from the plastic.

(2)

(ii) What happens to the incident ray as it enters the plastic?

(1)

.....

.....

(Total for Question 4 = 9 marks)

5 The chart lists some electromagnetic radiations.

radio	owave	infrared	visible light	ultraviolet	-ray	gamma

(a) Complete the table by giving one radiation from the chart for each use.

You may give each type of radiation once, more than once or not at all.

(3)

Use for radiation	Type of radiation
cooking	
treating cancer	
identifying broken bones	

(b) All types of electromagnetic radiation from the Sun are emitted with

(1)

☒ **A** the same amplitude

☒ **B** the same frequency

☒ **C** the same speed

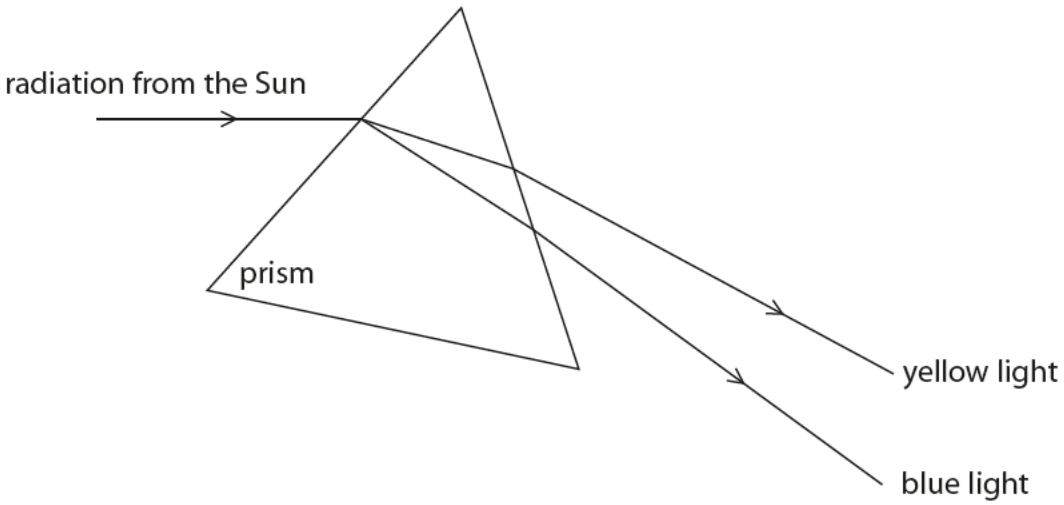
☒ **D** the same wavelength

(c) William Herschel was a scientist who investigated infrared radiation.

He passed electromagnetic radiation from the Sun through a triangular glass prism.

The prism refracted different radiations by different amounts.

The paths of yellow and blue visible light rays are shown in the diagram.



(i) Add to the diagram to show how the prism refracts an infrared ray.

(2)

(ii) William Herschel used a thermometer to detect infrared radiation.

He coloured the surface of his thermometer to make it more effective.

Which colour surface would work best?

(1)

☒ **A** black

☒ **B** red

☒ **C** silver

☒ **D** white

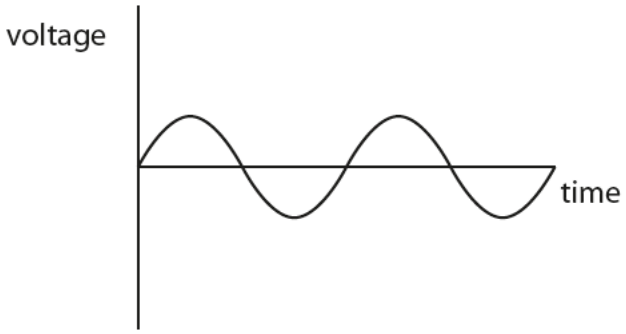
(Total for Question 5 = 7 marks)

6 (a) The graphs show oscilloscope traces produced by four different sounds. The oscilloscope settings are the same for each trace.

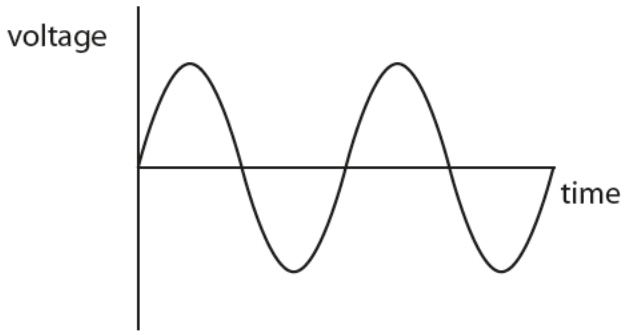
Which graph shows the trace for the loudest sound at the lowest frequency?

(1)

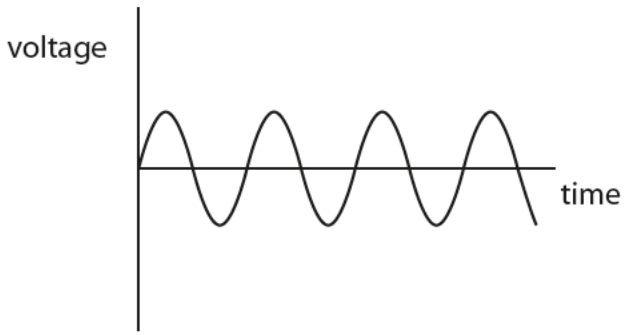
☒ **A**



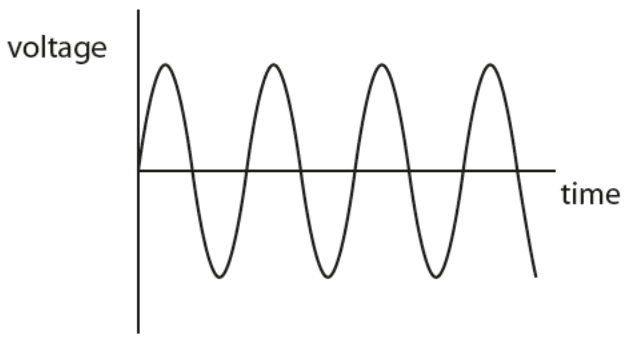
☒ **B**



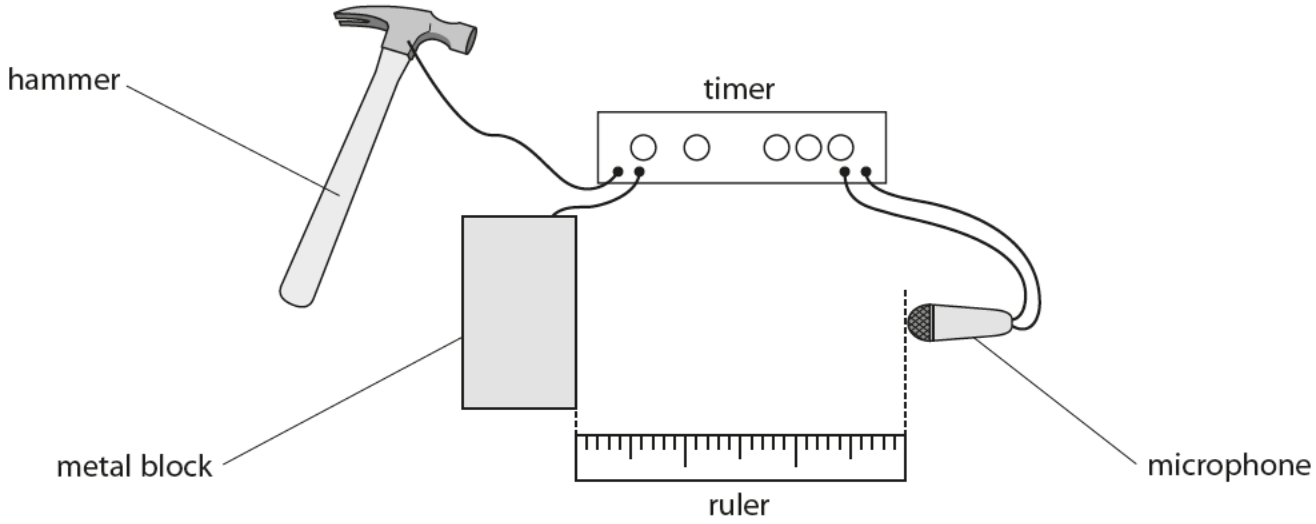
☒ **C**



☒ **D**



(b) The diagram shows the equipment used by a student to measure the speed of sound in air.



The student measures the distance between the front of the metal block and the microphone.

She then uses this method to measure the time taken for sound to travel from the metal block to the microphone.

- start the timer by hitting the metal block with the hammer
- stop the timer when the sound produced reaches the microphone
- record the time taken for sound to reach the microphone in milliseconds

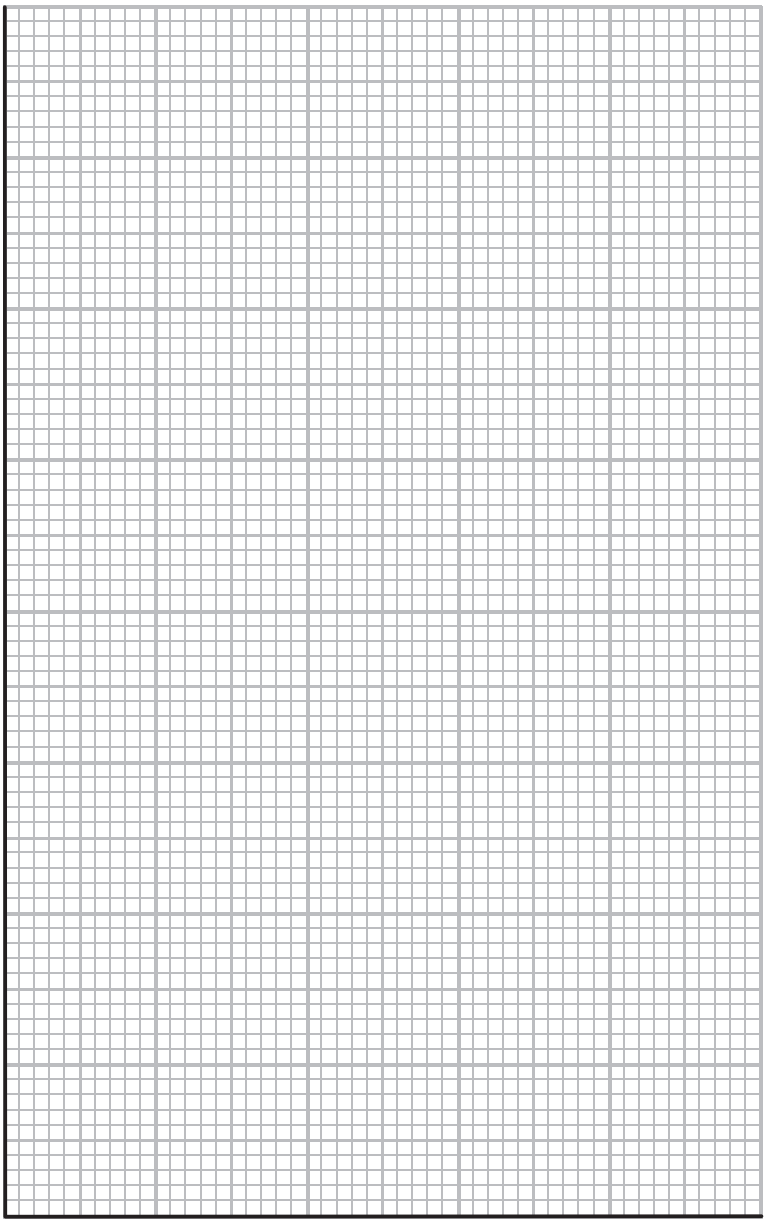
The student repeats the experiment six times, changing the distance between the metal block and the microphone for each experiment.

The table shows her results.

Distance in m	Time in ms
0.62	1.8
0.80	2.4
1.00	3.0
1.20	3.8
1.38	4.2

(i) Use the student's results to plot a graph of distance against time and draw the straight line of best fit.

(5)



(ii) Use your graph to find the speed of sound in air and give the unit.

(3)

speed = ... unit .....

(iii) Suggest how the student could make this experiment valid (a fair test).

(1)

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.....

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(iv) Suggest two ways that the student could improve the quality of her data.

(2)

1 .....

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2 .....

.....

(Total for Question 6 = 12 marks)

7 Somewaves travel across the sea. They all have the same wavelength.

a) What is meant by the term wavelength?

(1)

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(b) The waves travel across the sea at 3.0 m/s and have a frequency of 1.5 Hz.

(i) State the equation linking wave speed, frequency and wavelength.

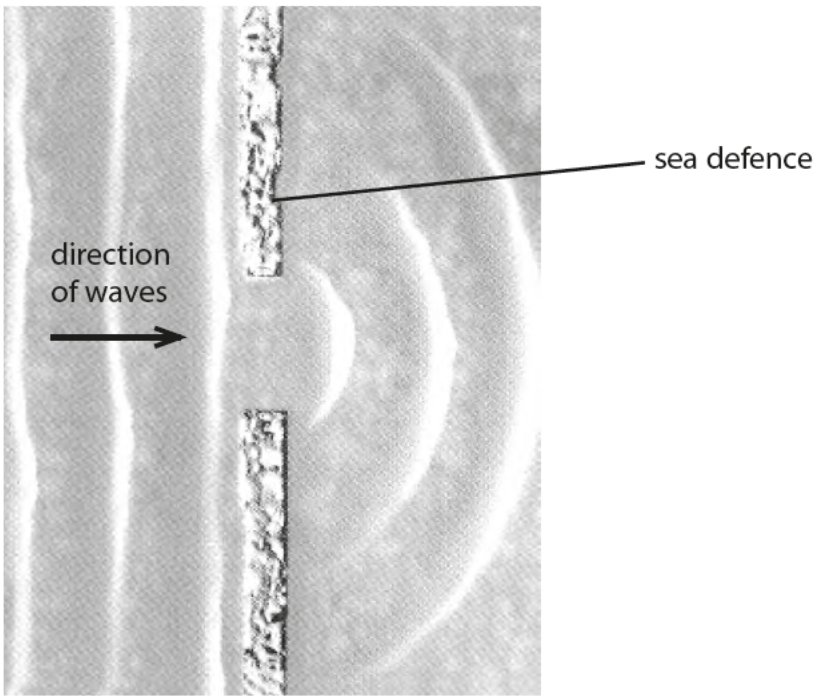
(1)

(ii) Calculate the wavelength of the waves.

wavelength ..... m

(2)

(c) This photograph was taken from an aeroplane. It shows a sea defence, with a gap in the sea wall.



Parallel waves pass through the sea defence at the gap in the sea wall, making the curved pattern shown in the photograph.

(i) Explain how this wave pattern is produced.

(2)

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(ii) Explain why light waves do not make a similar pattern as they pass through the same gap.

(2)

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(Total for Question 7 = 8 marks)

8 A foghorn makes a loud, low-pitched warning sound when a ship is moving in fog.



(a) What is the relationship between the frequency of a sound wave and the pitch of the sound?

(1)

.....

.....

(b) The foghorn emits sound waves with a frequency of 160 Hz.

The speed of sound is 340 m/s.

(i) State the equation linking wave speed, frequency and wavelength.

(1)

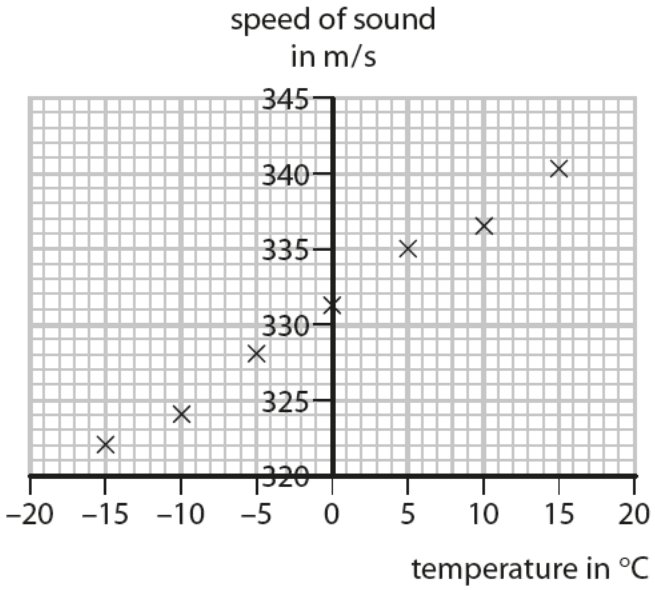
(ii) Calculate the wavelength of these sound waves.

(2)

wavelength = ... m

(c) A student investigates how the speed of sound in air varies with temperature.

The student's results are shown on the graph.



(i) Draw a straight line of best fit on the graph.

(1)

(ii) Use the graph to find the speed of sound when the air temperature is 20 °C.

(2)

speed of sound = ... m/s

(d) The air temperature decreases while the foghorn continues to emit sound waves with a frequency of 160 Hz.

Explain how this decrease in temperature affects the wavelength of the sound waves.

(2)

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(Total for Question 8 = 9 marks)